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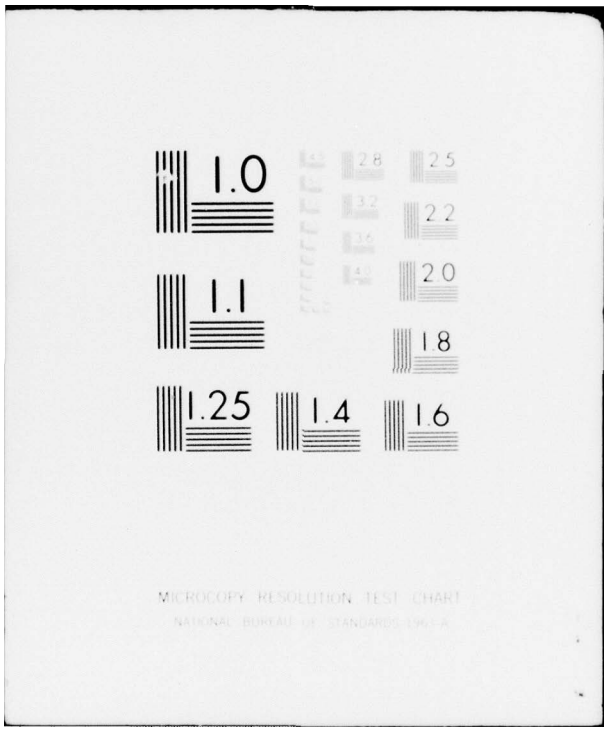
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CANNON-LAUNCHED GUIDED MISSILE

By

Wang Kuei

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CANNON-LAUNCHED GUIDED MISSILE

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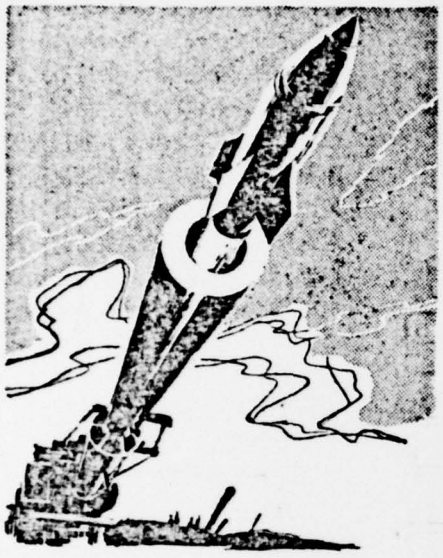
CANNON-LAUNCHED GUIDED MISSILE

WANG Kuei



A cannon-launched guided missile is a kind of guided missile launched by cannon. This article gives a simple introduction to its characteristics, uses, forms of guidance, the causes and developments.

CANNON-LAUNCHED GUIDED MISSILE

WANG Kuei

A cannon-launched guided missile is a kind of weapon which is produced in the process of the continuous development of weapon techniques. It has many characteristics which can be utilized in many respects.

CHARACTERISTICS AND USAGES

The so called cannon-launched guided missile uses a cannon to launch a guided missile. It is a combined product of gunnery techniques and rocket and guided-missile techniques. The untire weapon system is composed mainly of a cannon and a guided missile. Before launching, the guided missile is loaded into the cannon by the loading device (or load manually); the cannon is now loaded with the guided missile and propellant powder; at launching, the cannon is under the action of high pressure powder gas which causes the missile to be launched at a certain initial velocity and direction. Fig. 1 is a schematic diagram of loading the missile into the cannon.

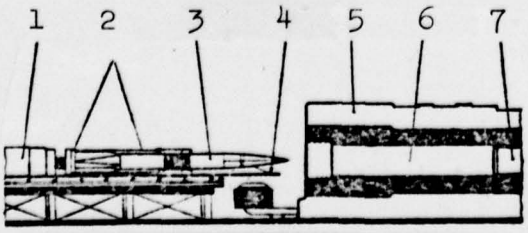


Fig. 1. Diagram of loading of cannon-launched guided missile.

Key to Fig. 1.

1. Rammer.
2. Ramming cover.
3. Cannon-launched guided missile.
4. Laoding tray.
5. Cannon.
6. Combustion chamber.
7. Smooth bore.

Within a fixed time after the missile leaves the cannon, the first-stage engine ignites, and then the second-stage engine ignites (this is the same ignition and flight as that of a regular guided missile). During flight, the missile is operated by a guidance system to deliver the warhead (the effective load) to the predetermined target and accomplish the mission of the cannon-launch guided missile.

The propulsion system of the cannon-launched guided missile mainly uses the present rocket engine and some other forms such as the external-burning auxiliary booster are under study. According to the requirements of war, the propulsion system of the cannon-launched guided missile uses one stage, two stages or three stages for propulsion. Most gun-fired antitank guided missiles of shorter range use one stage, but the ones with longer ranges use mostly two or three stages. Fig. 2 is a schematic diagram which shows the structure of the cannon-launched guided missile with a three-stage propulsion system. Fig. 3 shows the profiles of several typical cannon-launched guided missiles. In the same manner, the caliber of the cannon is also chosen according military requirements. The calibers of the cannon being used are several, such as 105 mm, 127 mm, 142 mm, 152 mm, 155mm, 203 mm, 406 mm, etc. For instance, the "space cannon" which is used in the study of the effect on the space vehicle when it reenters the atmospheric shell of the earth at a superhigh speed has a caliber of 406 mm and a barrel 55 meters long, and can launch a test missile to a suborbital altitude. Another instance is the model 2C1 gun-fired missile. The missile length is about 4.3 meters, the missile diameter is about 300 mm, it is

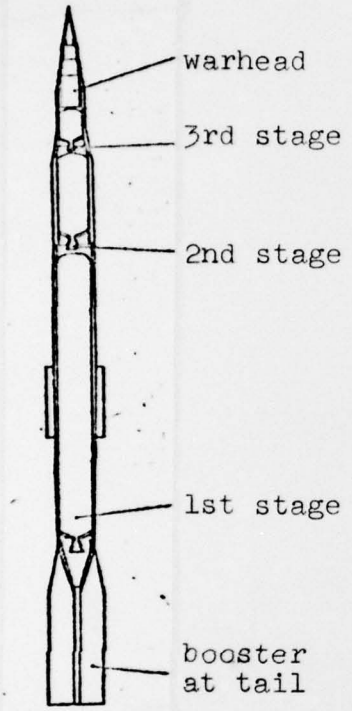


Fig. 2.
Diagram of a cannon-launched guided missile equiped with three engine stages.

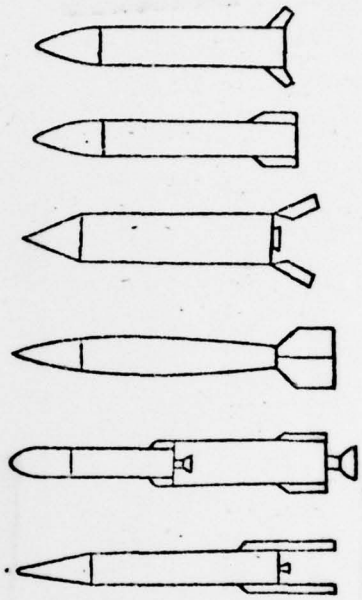


Fig. 3.
Contour figures of several typical cannon-launched guided missile.

propelled by a two-stage rocket motor, flight weight can reach about 550 kg, gliding altitude can reach 140 km, initial velocity can reach 1600 m/s, and in-bore acceleration is 5000 g (g is the acceleration of gravity). Fig. 4 is a picture of a foreign made cannon used for launching guided-missiles.

Fig. 4.
Picture of a foreign missille-launching cannon.

Comparative speaking, the cost of the cannon-launched guided missile is lower, and it has adopted many more modern techniques; thus, the cannon-launched guided missile has make itself applicable in many respects. It can be used in: 1) the study of reentry into atmospheric shell; 2) collecting geophysical and weather data; 3) the application of tactical weapons. For instance, the 152-mm "Shillelagh" gun-launched guided missile and the 142-mm "ACRA" gun-launched guided missile are fired from battle tanks to attack a moving target on the battlefield (such as tank), stationary target (such as a fortress), etc. There are also the 155-mm towed howitzer laser/IR duo-type controlled guided missile, the 127-mm and 203-mm laser guided missiles used on warships, etc. There are other types of cannon-launched items under study, such as a cannon-launched orbital vehicle, etc.

In comparison with other types of guided missiles, the cannon-launched guided missile has the following characteristics: 1) the initial muzzle velocity of the cannon-launched guided missile is rather high, that is to say, its initial velocity is very high and reaches more than Mach 5; 2) the cannon-launched guided missile has an initial launching direction; 3) the cannon is similar to the booster of a missile, but it can be used repeatedly; 4) the shell and equipment of the missile are under a very high acceleration, which may be from several to ten thousand g's, so the technical requirements are high and more difficult.

FORMS OF ATTACK AND METHOD OF GUIDANCE

The forms of attack and methods of guidance of the cannon-launched guided missiles are different in their uses. Some are guided along a director beam aimed at the target, such as the 142-mm "ACRA" antitank missile launched by a tank gun; some use semiautomatic laser beam guidance and target tracking and other forms of guidance. Take the cannon-launched guided missile of a howitzer to illustrate the guidance process simply: 1) it recognizes and determines the target, then passes this message to the gun, and the gun starts to aim at the target. At the same time, the laser target indicator emits a laser beam to aim at the target. 2) The

operator (whose position may be in the air or on the ground) controls the laser target indicator and aims the crosshair of the zoom lens at the target (the optical zoom lens is coaxially linked with the laser so that the laser beam axis coincides with optical axis of the zoom lens); the target then receives the laser beam and reflects it in all directions (it utilizes the basic characteristics of the laser beam which is strongly directional and has concentrated energy and small angle of divergence). Now, the launcher may fire the missile. 3) During the flight of the missile, the laser receiver on the missile receives the reflected energy from the target which is focused by a lens or reflecting mirror. When the strength of the laser signal in the receiver has reached to a certain degree, the missile then will lock on the target. The deviation of the axis of the missile from the direction to the target is detected generally by using a form of error voltage and is corrected by the control system. If the operator of the laser target indicator aims the crosshair of the optical sighting device at the target consistently, the missile will be automatically guided to the target during the tracking period. Fig. 5 is a diagram which shows a surface-to-surface target attack.

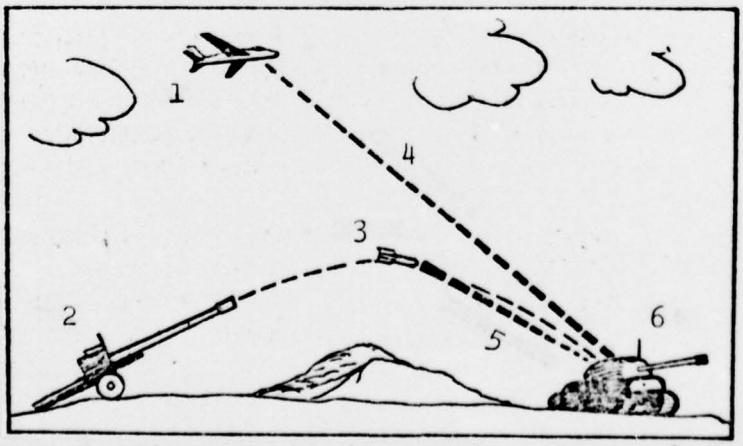


Fig. 5. Diagram showing surface-to-surface attack

Key to Fig. 5: 1) airplane, 2) cannon, 3)cannon-launched guided missile, 4) laser beam, 5) reflected laser beam, 6) target.

There are the locating stage and automatic tracking stage in the flight process of the guided missile. When the energy refleted from the target is not strong enough for the laser receiver to detect, the automatic target finder accomplishes angular scanning along the axis of the missile. Once it detects the reflected signal, the automatic target finder will lock on the target and automatically tracks it down until the warhead explodes.

ORIGIN AND DEVELOPMENT

Early in WWl, the Germans used a long range cannon and launched a flying vehicle to bomb Paris. That cannon had a barrel 36 meters long, muzzle velocity of 1600 m/s, the bomb weighed 106 kg, and the range was 128 km. Later, in the early forties there was a cannon with a caliber of 800 mm, the flight weight could be as heavy as 1800 kg, and the range was about 140 km. Besides, there were some other cannons with long firing ranges too.

In the late fifties and early sixties, there was a so called "high-altitude study project" which was a joint effort to study the long-range gun-launched flying vehicle. Subcaliber dart shells were launched to an altitude of 140 km by the smooth-bored cannon. The cannon-launched "Ma Te Le"* type 2C guided missile had made more than a hundred flights, its highest altitude was 180 km, and the total flight distance was about 400 km. Later, there was another joint "high-altitude study project" which was accomplished by England and Canada. A 406-mm cannon was used to launch the "Ma Te Le"* type-4 missile to carry and effective load into orbit. France also made a 155-mm smooth-bored cannon to launch some kind of cannon-launched flying vehicle. It is about 2.7 meters long and is propelled by a two-stage solid-fuel rocket engine. Remote measuring instruments are generally installed in the missiles and take an acceleration of up to 10,000 g's.

The many flight tests mentioned above were the results of using innumerable accomplishments of new techniques which are combinations of the techniques of cannons and the techniques of rockets and guided missiles. Due to the military expansion and the war preparations

* a possible transliteration

by the imperialists, a full scale arms race was initiated. On the basis of these tests, the gun-launched rockets for war use came to light. Among the presently manufactured weapons, the so called gun-launched rocket-boosted missile is one of them. The success of the remote measuring gun-launching research and the new sensitive elements which have small volume and can withstand high acceleration which have come into being made possible the realization of cannon-launched guided missiles.

The cannon-launched guided missile is used as a tactical weapon because it can be guided and has higher accuracy; a single shot could hit the target. It may take ten or a hundred rounds of unguided shells to hit the target. Comparatively speaking, the guided missile is more economical.

The technical requirements of the guided missile are rather high and more difficult, especially for some uses; therefore, the cannon-launched guided missile cannot be a simple combination of "cannon and guided missile". To speak from certain aspect, the characteristics of the cannon used for launching the guided missile are better than those of the regular cannon; even the cannon-launched guided missile itself, which includes the shell, power plant, electronic devices, and sensitive elements which could not be simply transferred from other guided missiles must be specially designed structurally to satisfy the requirements of high acceleration and small volume. This is the only way to ensure the use of the cannon-launched guided missile. In order to satisfy the above-mentioned requirements, all technical achievements must be utilized so that the cannon-launched guided missiles with different purposes become realistic. The directions of development are: 1) Improving the cannon. The main steps are to use light metal and a new structure, etc., so that the weight of the cannon can be reduced and the strength can be increased; increasing the barrel correpondingly and improving the propellent; using the end surface burning of the propellent and multipoint ignition in order to increase the initial velocity of the cannon-launched guided missile, and to make the missile to receive smaller acceleration. The research of a liquid

propellent for cannon use (liquid cannon) which can increase the range of the guided missile is now under way. It is said that this is a poisonless propellent, it has some advantages such as higher rate of fire , is safe in use, has lower maintenance and logistics costs, etc. According to the report there is a non-pyrophorous liquid bipropellent in the U.S. It uses diluted nitric acid as oxidizer, octane as fuel. 2) Improving the rocket. Select a high-performance and light weight material to make the shell of the rocket engine; use a new method to pour the propellent grain to increase the strength of the propellent grain; use a binding brace, end support, and liquid support methods to reduce the acceleration acting on the propellent grain while it is in the barrel. The requirements of the propellent grain are high rate of burning, high energy, and high payload. Thus the mass ratio of the cannon-launched guided missile may be greatly increased. By comparing the guided missile which uses a whole body type rocket-ram composite engine with the guided missile which has another engine with a similar tactical index, the former missile is smaller in caliber, shorter in length, lighter in weight and perhaps is better for employment for certain cannon-launched guided missiles. 3) Finding a new guidance device. The cannon-launched guided missile requires the guidance device to be miniaturized and microminiaturized and also can withstand the acceleration of from several thousand up to ten thousand g's. Thus, the techniques of sealing the electronic components have been proven by tests to have good effects. With respect to sensitive elements, there are no moving parts in the laser gyro, it can take high acceleration, it is light in weight and its volume is small, and it has a good future. A flow (fluid or fluidic) controlled gyroscope has simple structure; it has no or few moving parts and could be microminiaturized. The U.S. has used it in the cannon-launched guided missile and reported that it can withstand an acceleration of 1,000 g's.

At present, the cannon-launched guided missile is still a rather new weapon system. However, we can see that its occurrence and development are a result of the highest form of class struggle

---a product that war has a continuous demand for new tactical techniques for a weapon system is the result of the development of productive power and the scientific-technical level which provide the objective possibility of implementing the demand. In spite of the fact that the cannon-launched guided missile is now still in the early developmental stage, from the point of view of economics and present achievements it might be a multipurpose weapon system with future developments.

In general, following the class struggle, the production struggle, and the continuous developments of scientific experiments, it is possible that the existing problems in the cannon-launched guided missile can be solved one by one as it approaches perfection.

SIMPLE INTRODUCTION:

GENERAL CHARACTERISTICS OF THE REGULAR CANNON----Presently the general caliber of regular cannon used in the field in foreign countries is between 100-200 mm. The weight of this type of cannon is more than a ton, and some are more than 10 tons. Shells weigh from several dozen kg to about 100 kg. The firing range is about ten km or more. For instance, the U.S.-made M.114 cannon has a caliber of 155 mm, weighs 5.75 tons, the shell weighs 45 kg, the firing range is 15 km, and this is a typical tactical artillery piece.

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